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Clinical case report

Twisted-Files Adaptive: A Novel Approach to Endodontic NiTi Instrumentation

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A major goal of Endodontics is the prevention or elimination of "apical periodontitis". Apical periodontitis is the general term for endodontic related periradicular/periapical inflammation, whether it is histologically a granuloma, cyst or abscess, in symptomatic or asymptomatic form.[1] When root canal treatment is indicated, we rely on the triad of instrumentation, irrigation and obturation to achieve this goal.

Instrumentation has come a long way since we first started using NiTi alloy in root canal preparation. Initially research concentrated mostly on features of file design such as taper, cross section, blade rake angle, pitch, tip design and so on. We then went on to improving the metallurgical properties of NiTi alloys for even more enhanced flexibility and fracture resistance. More recently we started also researching kinematics of NiTi files in root canals in the search of optimised preparation.

Today we know a lot about advantages and disadvantages of features from all these three categories through the vastly accumulated evidence based research. 'TF-Adaptive', as a motor and file system, was brilliantly designed with a focus on providing the clinician with a huge set beneficial features at hand while greatly reducing the potential limitations. During canal preparation the system shifts automatically between file rotation motion and reciprocation, each when most desired and appropriate.

This in turn results in an ability to safely prepare root canals – file separation almost worry free – not only quicker then before but also respecting the original canal trajectory, improving circumferential canal preparation and greatly minimising debris extrusion compared to other reciprocating systems.[32]

Rotation vs. reciprocation

From the 90s,"traditional" NiTi root canal instrumentation has been done through continuous instrument rotation. More recently, Yared introduced the concept of canal instrumentation using a single NiTi file using reciprocation movement.[2] Since then, reciprocation has been the focus of much research and designated motors and NiTi files have been brought to market. The benefits of reciprocation helped in making these file systems quite popular.

In time, independent research has shed more light on these advantages but also on disadvantages when comparing root canal preparation by reciprocation with the traditional continuous rotation. We now know that when considering some important aspects, continuous rotation remains superior to reciprocation, while the opposite is true when considering other aspects.[9,13-16] TF Adaptive is the only system to smartly empower the clinician with both features in one single program mode. It does this by a sophisticated automatic torque algorism that uses rotation when we want it and reciprocation when we need it. The system does this skillfully, eliminating the need for clinicians to switch between the programme settings on the endo motor during canal shaping.

In a reciprocating movement the file rotates in one direction, engaging and cutting the dentin, and then rotates back to a lesser degree, disengaging from the dentin. This extends the cyclic fatigue resistance on the file, reducing stress on the instrument to a degree where it is possible to prepare the entire root canal using a single NiTi file.[12,17,11,23, 25] This is usually not possible when using NiTi files

TF-Adaptive as a complete system (motor+files) combines superior features from all fronts of endodontic instrument science, i.e. file movement kinematics, file shape and metallurgy, taking us to the next level in perfection of root canal preparation. It gives me confidence to prepare highly curved canals without the fear element of file separation, while operating so much quicker then ever before.

The outcome is enhanced circumferential canal preparation for better irrigation and reduced extruded debris related postoperative pain. I absolutely love working with it.

in a continuous rotation motion and serves as a strong selling point to preparation by reciprocation vs. by rotation.

The other major advantage of reciprocating movement is the ability to better preserve original canal trajectory (Fig 1.).[16,26] This is attributed to overall lower instrumentation stress applied on canal walls. However, other factors need consideration too and rigid files or ones with cutting tip designs would (negatively) greatly affect and promote transportation, even when a file reciprocates. It can also be argued that preparing canals with a single NiTi file is simpler and to some degree might be quicker.[18,19,20]

On the other hand preparation by pure reciprocation is known to increase the incidence of post-operative pain, brushing laterally may be less efficient, less emphasis is given to the straight line coronal access (pre-flaring) phase of preparation and also apical enlargement is not always addressed by a single NiTi file.

1. Increased incidence of post-operative pain is due to significantly greater debris pushed out as a consequence of the file movement in a full reciprocating mode.[9,32] This is true for vital cases and even more so when, in non vital cases, the debris being pushed out is infected.[22] On the other hand, in pure rotation, file flutes are designed to push debris upwards away from the apex, resulting in significantly less debris pushout.[21,19]

2. After shaping to entire canal length and reaching the master apical file, we want to brush laterally to achieve as much main canal circumferential cleanliness as possible in an asymmetric oval canal where our instrument is round and centered. Rotation with ultra flexible files (such as Twisted Files) with effective cutting blades does this job more efficiently than with a reciprocating motion.[4,29,30] This is achieved beautifully using the TF Adaptive System in the "TFA Program Mode". Given the width of the canal at this stage, the file works in rotation only with low torque applied on it. The same could be achieved also by switching to the pure "Twisted File Full Rotation Mode" at a push of a button on the motor.

3. Single file endodontics is not always advised, especially when treating molar teeth where different canals of the same tooth may vary greatly in dimensions. For example, a single reciprocating file size 25 with taper .08 might be sufficient when preparing MB1 and DB canals of an upper first molar tooth. Yet in most cases this file size would not be as compatible for MB2 canals, and certainly not compatible for the P canal of the same tooth. In such cases, if a single reciprocating file is used, we may need to resort at a later stage to the step back or other rigid files techniques for apical enlargement. This is still far less beneficial than simply using several highly flexible NiTi files of various taper and apical dimensions to tailor our needs and combat each canal more specifically, without compromise. The TF Adaptive System lets us decide during each case whether to complete the work using a single NiTi file or to adapt with one or two more files. The "bigger" files (yellow and then red) are designed with enlarged apical size but with reduced taper. They therefore remain highly flexible despite being bigger in size.[10] This feature is important when the canal is highly curved but at the same time a greater size apical enlargement is required. This is easily and safely done with the apically wider yellow and red TFA files after the smaller green one (ML1) took care of the taper in the coronal two thirds of the canal.

4. Lastly, there is the misconception about pure reciprocating systems being truly single NiTi endodontics, where in reality it is recommended to firstly produce a glide path wide enough to require up to three more files, which may be NiTi ones.[33, 34]

R-Phase technology

NiTi alloys are super elastic (highly flexible) and have shape memory (return to original shape after flexing) due to a reversible atomic crystal lattice shift between the Austenite and deformed Martensite states. This atomic shift happens when external tension is applied on the file by the root canal.[24]

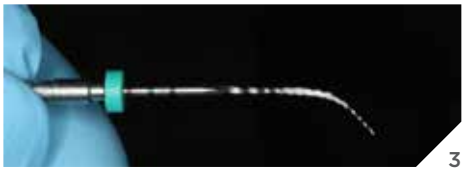
However, the ability to create this atomic shift also depends on ambient temperature and on the alloy's thermal pre-treatment during the manufacturing of the endodontic file. Manufacturing with specific thermal pre-treatment, (know as R-Phase), further contributes to the ability of the NiTi file to absorb stress and resist fatigue resulting in greatly enhanced file flexibility compared to NiTi's manufactured with traditional techniques. Twisted Files are manufactured by twisting the raw material to shape during a thermal cycle that transforms into the R-Phase.[7]

As mentioned above, the reversible atomic confirmation also depends on ambient temperature. It is interesting to note that at room temperature, the atomic file confirmation is in the stable Austenite phase. We need to actually reduce the temperature in order to shift into the Martensite phase. Manufacturing under R-Phase gives the file properties which allow us to cool a file chair-side with a conventional endo cold spray to a temperature range where the NiTi file stays bent long enough for us to pre-curve the file, like we do with stainless steel ones (Fig. 2 and 3).[8,25] This is greatly beneficial when managing ledged root canal cases (Fig. 4).

Until this technology came along, the conventional approach for ledge management required extra work and chair-time using one pre-curved stainless steel files after the other.[27]


1


2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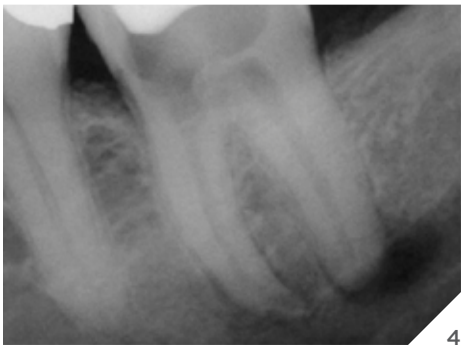
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5

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Fig. 1 – High degree curvature in apical third of distal root canal.
Fig. 2 – TFA-SM1.
Fig. 3 – TFA-SM1 kept at a pre-bent state with help of cold spray.
Fig 4 – Referred case with ledge in apical third of mesial canal.
Fig 5 – 1 year review. Ledge was managed with pre-bent SM2. Healing apical tissues.
Fig. 6 – Double curvature management with reduced risk to file separation in the second curve.

Without doing this first the normal NiTi file would go naturally into and stop at the ledge point. Even more so, the very severe ledges could not be "cancelled" well enough with stainless steel. These cases required the continuation of canal preparation to master apical file without being able to use NiTi files at all.

Having cooled the TF Adaptive File with a cold spray, we pre-bend the file, quickly insert it with a tactile hand motion beyond the ledge, then connect it to the headpiece and choose to either first brush laterally in an anti-curvature up/down motion trying to cancel the ledge as much as possible, or continue with gentle down-pecking apically instead. It is also important to note that canals with problematic ledges which were effectively prepped to length with NiTi files are easier to obturate with the continuous wave of obturation warm technique, as opposed to those prepped with stainless steel alone.

Innovative file design[28]

Twisted Files are the only files in the market manufactured in the same way as stainless steel ones, by twisting them into shape. This is done during the thermal cycle that transforms into the R-Phase.

- The result is a smooth and continuous file surface. All other NiTi files are grounded into shape. The machining process leads to machining grooves on the surface of the file. File fracture always starts at the weakest link. These machining surface grooves serve as initiation points for cracks and then possibly file fracture.[31]
- In addition to twisting, Twisted Files then further undergo a process of surface deoxidation for even more enhanced surface smoothness.[5, 6]
- The Twisted Files' cross section is a triangular one. This results in effective dentin cutting allowing us to use the same file both as a reamer and then later as a Hedstrom file to effectively brush laterally.
- The Twisted Files' pitch configuration varies along the file rather than being constant. This reduces the "pull-in" effect and creates smooth tracking during root canal preparation.
- The Twisted Files' tip is a safe ended non cutting pilot. The tip guides and does not dig. This helps in reducing occurrences of canal transportations.

The TF Adaptive way

Operator use feels 'different' compared to pure rotating modes, yet the overall learning curve is quick and you get to love the entire system very soon.

The system is designed to shift automatically between interrupted rotation to start with and reciprocation. The rotation reaches 600 degrees then stops and restarts to a new 600 degrees loop. This gives the benefits of rotation, i.e better cutting and debris being pushed upwards. With increased load further down the canal and beyond the curves, the system will then gradually shift to varying reciprocation angles, as required. This is different to the traditional reciprocation systems with constant clockwise/counter clockwise angles. Under higher torque stress, TF Adaptive rotates 370 degrees clockwise and up to 50 degrees counterclockwise. This provides further safety against file separation and canal trajectory is highly respected (Fig. 5 and 6).[10, 32] The ML (Medium Large) file set is a true crown-down technique. The taper of the first file facilitates better irrigation while the next ones work more on apical enlargement. The SM (Small) set manages sclerotic cases.

Clinical tips

Following access cavity preparation, achieving straight line access is an important step prior to inserting a file and measuring the working length. Next, achieving a glide-path is important. In the ML set, the green file .08/25 will usually do most of the work in the canal. It is tempting for the clinician to peck it up/down apically all the way to working length in one go because the system is efficient and therefore in many cases capable of doing so. Avoid doing this and once the file engages dentin, take it out to clean flutes, irrigate the canal and remember to maintain recapitulation. File unwinding is unlikely to occur if the above rule is followed. However, in rare cases when it does happen, it should serve as a unique cautionary sign before file separation, and as a warning to the operator that the hand pressure applied apically on the handpiece was higher than advised.

After ML1, the ML2 .06/35 will often go effortlessly straight to working length. This is greatly beneficial for apical enlargement, reduces the risk of file separation. Depending on original canal size/complexity, this is also true when ML3 is needed. Achieving MAF (master apical file) of ML2 (.06/35) also means we can use an EndoVac irrigation system to better disinfect the root canal system. After MAF is achieved, I prefer final lateral brushing in the regular "TF Full Rotation Programme Mode" however this can also be done in the "TF Adaptive Mode". The file will feel minimal torque and therefore brush in interrupted rotation 600-0 degrees and not reciprocation eciprocation.

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